Determining important parameters related to cyanobacterial alkaloid toxin exposure

Love, A.H.[1]

[1] Forensic Science Center, Lawrence Livermore National Laboratory

Toxins Session - Bioterrorism

Introduction

Biotoxins span the intersection of chemical and biological weapons, in that they are chemical compounds that are naturally produced by biological organisms. The acute toxic nature of some cyanobacterial alkaloid toxins at low concentrations results in special interest with regards to fate and persistence information. Acute cyanobacterial toxins are unique compared to protein biotoxins because they are small molecular weight toxins that, in addition to their natural production, can be synthetically produced. These compounds also have unique physico-chemical properties compared to other chemical and biological weapons. Alkaloids are usually small molecular weight organic compounds (~150-450 Da) with basic functional groups and a heterocyclic ring containing at least one nitrogen atom. Numerous procedures are published for extraction and direct synthesis of many of these compounds.

Knowledge of Fate and Persistence/Signatures

Reliable fate and persistence parameters improve the prevention of, preparation for, and response & recovery from cyanobacterial toxin exposure. Consideration of intentional contamination using these toxins contributes additional questions about physico-chemical signatures that are capable of distinguishing between natural and intentional occurrences. Our current understanding of the interactions between acute cyanobacterial toxins and environmental matrices is extremely limited and prevents an accurate assessment of their potential threat. A quantitative and mechanistic understanding will result only from the careful integration of quantitative measurements and modeling the impact of fate and persistence for these compounds under various physico-chemical conditions. Also, detailed study of the procedures for achieving high concentrations of these compounds through extraction or synthesis are needed to create forensic tools for the identification of the source of such toxins. The unique physico-chemical properties of these toxins warrant individual attention in order to ensure high fidelity in the actions taken to address potential cyanobacterial alkaloid toxin exposure.

Detection

Ultimately, the protocols developed for preparing and responding to cyanobacterial toxin occurrences will directly draw from our knowledge of these toxins and integrate the important parameters into planning and recovery. The structural nature of cyanobacterial alkaloid toxins limits potential analytical techniques. Knowledge of the matrix effects and analytical infrastructure is required for unequivocal identification of cyanobacterial toxin exposure. The approach for integration of analytical capabilities into detections systems designed for either detect-to-warm or detect-to-treat is being investigated. Incorporation of signatures into a detection system approach would aid in distinguishing natural vs. intentional contamination.

Conclusions

Numerous naturally produced toxins have the potential for both accidental and intentional contamination. Cyanobacterial alkaloid toxins are just one example where numerous questions exist. More information is needed from research efforts that integrate experimental results, simulations, and modeling of fate and detection of these toxins. Improving our knowledge in these areas has dual-use, for understanding both natural and intentional contamination, and therefore should have double the impact factor. Research collaboration and formats for information exchanges are needed as such steps will result in the most rapid and efficient advances which limit potential future exposure to these toxins.